CHAPTER V

SOIL/LAND IRRIGABILITY CLASSIFICATION

The Soils of Gujarat, are broadly divided into four groups, viz. alluvial soils, desert soils, saline/alkaline soils and lateritic soils (Appendix II.2 p.245). The soil map of Gujarat is reproduced fron Census Atlas - 1961 (Map V.1).

SOIL SURVEY

The main object of soil survey, was to get comprehensive information about the soils of the study area for broad irrigation and land use planning. The rapid reconnaissance soil survey was carried out on one inch Toposheet No. $41\frac{N}{2 \& 6}$. Soil samples were collected from 30 augerbores spaced at a distance of 6.9 km (4.4 miles) approximately. Physical and chemical properties of these soil samples, were studied in the field and in the laboratory. Soils were classified into well defined irrigable soil classes, on the basis of the above studies, Land features were also studied in the field near each augerbore site. Land irrigability classification is based on soil/land characteristics. The soil/land irrigability classes are

marked on the base map.

FIELD OBSERVATIONS

Based on colour and textural variations, the soil samples from 30 augerbores were collected from various depths and identified in the field. The observations and their test results are given in Table V.1. The observations of the salient land features of this area were made near each augerbore site (Table V.2).

The soil characteristics, viz. soil depth, soil colour, soil texture, lime content, soil moisture and parent material, are described below:

SOIL DEPTH: The depth of soil at augerbore sites, varies from moderately deep to deep and is very deep at places, viz. Shekhardi, Sadharka, N of Sidsar, Sarsana and Hirana.

The details of variation in soil depth above the parent materials, are given in the following table :

TABLE V.01

FIELD TEST RESULTS OF AUGERBORE SOIL SAMPLES

Auger-bore No.	Location	Sampling depth (cm)	Soil Colour		Soil Texture	Lime Reaction	Soil Moisture
			Munsell Notation	Descriptive Name			
1	2	3	4	5	6	7	8
1	Sayla	0-15	10YR 5/3	Brown	Sandy Loam	Feeble	Just moist
		15-55	10YR 5/3	Brown	Sandy loam mixed with Kankar	Vigorous	Just moist
		55+	Weathered Trap				
2	Bhaduka	0-15	10YR 5/3	Brown	Loamy Sand	Feeble	Dry
		15-45	10YR 5/3	Brown	Loam	Violent	Just moist
		45-70	10YR 6/3	Light Brown	Sand mixed with Kankar	Violent	Just moist
		70+	Sandstone				
3	Dolia	0-15	10YR 5/3	Brown	Loamy Sand	Vigorous	Just moist
		15-45	10YR 6/3	Light Brown	Loamy Sand	Violent	Just moist
		45+	Sandstone				
4	Chorvira	0-15	10YR 6/3	Light Brown	Sandy loam	Feeble	Just moist
		15-30	10YR 5/3	Brown	Loamy Sand	Nil	Just moist
		30+	Sandstone				

contd...

TABLE V.01 (contd.)

1	2	3	4	5	6	7	8
		0-11	10YR 5/2	Greyish Brown	Loamy sand	Nil	Dry
5	Than	11-45	10YR 3/3	Dark brown	Sandy clay loam	Nil	Just moist
		45-55	10YR 3/3	Dark brown	Sandy clay loam	Nil	Just moist
		55+	Sandstone				
		0-15	10YR 5/2	Greyish brown	Loamy sand	Nil	Dry
6	Rampara	15-45	10YR 3/3	Dark brown	Loamy sand	Nil	Moist
		45-85	10YR 3/3	Dark brown	Loamy sand	Violent	Just moist to dry
		85+	Calcareous Sandstone				
		0-15	10YR 5/2	Greyish brown	Loamy sand	Vigorous	Dry
7	Shekhardi	15-45	10YR 3/3	Dark brown	Clay loam	Vigorous	Just moist
		45-95	10YR 4/2	Dark greyish brown	Clay loam with lime nodules	Feeble	Just moist
		95-115	10YR 5/3	Brown	Clay with lime nodules	Violent	Just moist
		115+	Ferruginous Sandstone				
		0-28	10YR 5/2	Greyish brown	Sandy clay loam	Vigorous	Dry
8	Jodhpur	28-56	10YR 5/3	Brown	Clay loam	Vigorous	Moist
		56-82	10YR 3/3	Dark brown	Clay	Vigorous	Moist
		82+	Weathered trap				

contd...

TABLE V.1 (contd.)

1	2	3	4	5	6	7	8
		0-20	10YR 5/2	Greyish brown	Sandy clay loam	Feeble	Dry
9	Sadharka	20-60	10YR 3/3	Dark brown	Sandy clay loam	Vigorous	Just moist
		60-110	10YR 3/3	Dark brown	Clay with lime nodules	Violent	Moist
		110-125	10YR 5/2	Greyish brown	Clay with lime nodules	Violent	Just moist
		125+	Weathered trap				
		0-15	10YR 5/2	Greyish brown	Sandy loam	Vigorous	Dry
		15-45	10YR 5/3	Brown	Sandy clay loam	Feeble	Moist
10	Sarsana	45-90	10YR 3/3	Dark brown	Clay loam	Feeble	Moist
		90-120	10YR 3/3	Dark brown	Sandy clay loam	Feeble	Moist
		120-130	10YR 5/3	Brown	Gravelly clay loam	Feeble	Dry
		130+	Sand				
		0-10	10YR 5/2	Greyish brown	Loamy sand	Violent	Dry
11	Songadh	10-30	10YR 3/3	Dark brown	Sandy clay loam	Violent	Just moist
		30-70	10YR 5/2	Greyish brown	Sandy clay loam	Violent	Dry
		70+	Sandstone				

contd....

TABLE V.9 (contd.)

1	2	3	4	5	6	7	8
		0-15	10YR 5/3	Brown	Sandy loam	Nil	Dry
12	Vagadia	15-30	10YR 5/3	Brown	Sandy loam	Nil	Dry
		30-60	10YR 6/3	Light yellow-ish brown	Sand	Nil	Just moist
		60+	Weathered Sandstone				
		0-15	10YR 5/3	Brown	Sandy loam	Nil	Dry
13	Khatdi	15-30	10YR 5/3	Brown	Sandy loam with Kankar	Feeble	Just moist
		30+	Calcareous Sandstone				
		0-15	10YR 5/3	Brown	Sandy loam	Feeble	Dry
14	N. of Sidsar	15-45	10YR 5/2	Greyish brown	Sandy loam	Feeblo	Dry
		45-110	10YR 5/2	Greyish brown	Sandy clay loam	Vigorous	Just moist
		110+	Weathered trap				
		0-15	10YR 5/3	Brown	Sandy loam	Feeble	Dry
15	N. of Sayla	15-50	10YR 3/3	Dark brown	Sandy loam	Feeble	Just moist
		50-70	10YR 5/2	Greyish brown	Sandy loam to sand	Violent	Just moist
		70+	Calcareous Sandstone				

contd...

TABLE V.4 (contd.)

1	2	3	4	5	6	7	8
16	N. of Muli	0-15	10YR 3/3	Dark brown	Sandy clay loam	Vigorous	Just moist
		15-30	10YR 3/3	Dark brown	Sandy clay loam	Vigorous	Just moist
		30-60	10YR 3/3	Dark brown	Sandy clay loam	Vigorous	Just moist
		60-85	10YR 5/2	Greyish brown	Sandy clay loam	Violent	Just moist
		85+	Weathered trap				
17	Dholia	0-15	10YR 5/3	Brown	Sandy clay loam	Feeble	Dry
		15-40	10YR 5/3	Brown	Sandy loam	Nil	Just moist
		40+	Sandstone				
18	Tarnetar	0-15	10YR 6/3	Light brown	Loamy sand	Nil	Dry
		15-40	10YR 6/3	Light brown	Loamy sand	Nil	Dry
		40-75	10YR 5/3	Brown	Sand	Nil	Just moist
		75+	Ferruginous Sandstone				
19	Lunsar	0-20	10YR 5/2	Greyish brown	Sandy loam	Feeble	Dry
		20-50	10YR 5/2	Greyish brown	Sandy clay loam	Feeble	Dry
		50-75	10YR 5/3	Brown	Loam	Feeble	Dry
		75-85	10YR 5/3	Brown	Loam	Feeble	Just moist
		85+	Sandstone				

contd...

TABLE V.1 (contd.)

1	2	3	4	5	6	7	8
		0-15	10YR 4/2	Dark Greyish brown	Sandy clay loam	Nil	Dry
20	Makhtanpur	15-40	10YR 4/2	- do -	Sandy clay loam	Nil	Dry
		40-60	10YR 4/2	- do -	Sandy clay loam	Nil	Dry
		60+	Clay deposit increased as depth increased due to low lying area				
		0-15	10YR 6/3	Light brown	Loamy sand	Nil	Dry
		15-30	10YR 6/3	Light brown	Sandy loam	Nil	Dry
21	Ranipat	30-70	10YR 5/3	Brown	Sandy loam	Nil	Moist
		70-90	10YR 5/3	Brown	Sandy loam	Nil	Moist
		90+	Sandstone				
		0-15	10YR 5/3	Brown	Sandy loam	Feeble	Dry
22	Khampalia	15-45	10YR 5/3	Brown	Sandy loam	Feeble	Just moist
		45-65	10YR 5/6	Yellowish brown	Loamy sand	Feeble	Just moist
		65+	Yellow Sandstone				
		0-15	10YR 5/3	Brown	Sandy loam	Nil	Dry
		15-45	10YR 5/3	Brown	Sandy loam	Nil	Just moist
23	Sarla	45-75	10YR 5/3	Brown	Sandy loam	Nil	Just moist
		75-90	10YR 6/3	Light Pale brown	Sand	Nil	Just moist
		90+	Sandstone				

contd...

TABLE v.9 (contd.)

1	2	3	4	5	6	7	8
		0-15	10YR 5/2	Greyish brown	Sandy loam	Nil	Dry
24	Tikar	15-30	10YR 5/2	Greyish brown	Sandy loam	Nil	Just moist
		30+	Sandstone				
		0-15	10YR 6/3	Light brown	Sandy loam	Nil	Dry
		15-45	10YR 6/3	Light brown	Sandy loam	Nil	Just moist
25	Hirana	45-80	10YR 5/3	Brown	Sandy loam		Moist
		80-120	10YR 5/6	Yellowish brown	Sandy loam	Nil	Moist
		120+	Sandstone				
		0-15	10YR 6/3	Light brown	Sandy loam	Nil	Dry
26	Chitarkhada	15-30	10YR 6/3	Light brown	Sandy loam	Nil	Just moist
		30+	Sandstone			Nil	
		0-15	10YR 5/3	Brown	Sandy loam	Feeble	Dry
27	Sagadhara	15-30	10YR 5/3	Brown	Sandy loam	Vigorous	Just moist
		30-90	10YR 6/3	Light brown	Sandy loam	Vigorous	Just moist
		90+	Sandstone				

contd...

TABLE V.1 (contd.)

1	2	3	4	5	6	7	8
		0-15	10YR 5/3	Brown	Sandy loam	Feeble	Dry
28	Rajgad	15-45	10YR 5/3	Brown	Sandy clay loam	Feeble	Just moist
		45+	Sandstone				
		0-15	10YR 5/3	Brown	Sandy clay loam	Feeble	Just moist
29	Aya Dagdagia	15-30	10YR 5/3	Brown	Sandy loam	Feeble	Just moist
		30+	Sandstone				
		0-15	10YR 5/3	Brown	Sandy loam	Nil	Dry
30	Palasan	15-45	10YR 5/3	Brown	Sandy loam	Nil	Just moist
		45-80	10YR 6/3	Light brown	Loamy sand	Nil	Just moist
		80+	Sandstone				

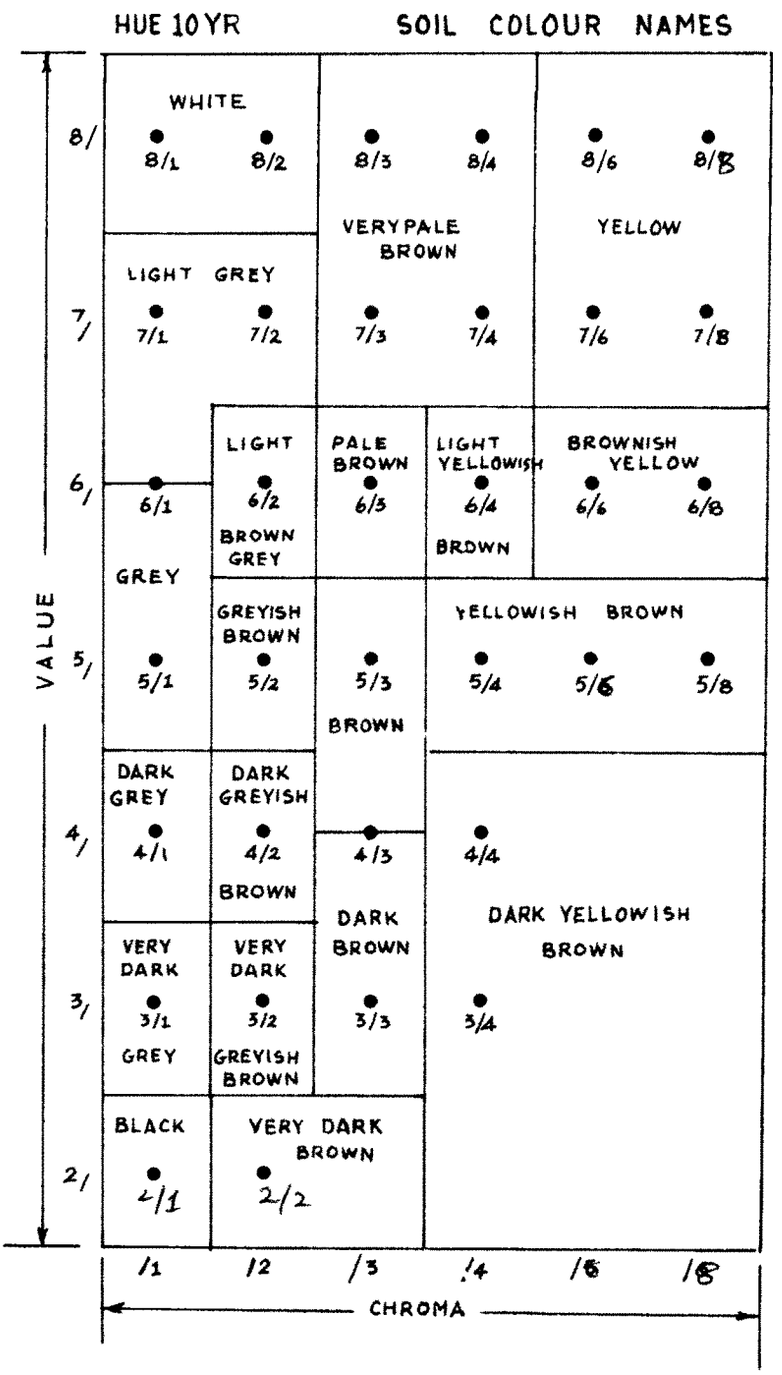
Descriptive Name	Depth Range (cm)	Augerbore Numbers
Very shallow to shallow	0 - 22.5	Nil
Moderately deep	22.5 - 45.0	3,4,13,17,24,26,28,29
Deep	45.0 - 90.0	1,2,5,6,8,11,12,15,16, 18 to 23, 27, 30
Very deep	Over 90.0	7,9,10,14,25

SOIL COLOUR : The surface soils are brown to greyish brown and the sub-surface soils are brown to dark broan.

The details of colour variations in soils and their Munsell colour notations (Fig. V.1) are given in the following table :

Descriptive Name	Munsell Colour Notations	Augerbore Numbers	
		Surface Soil (0-15 cm)	Subsurface Soil (15-90 cm)
Dark brown	10YR 3/3	16	5,6,8,9,10,15,16
Dark greyish brown	10YR 4/2	20	7,20
Greyish brown	10YR 5/2	5 to 11,19,24	11,14,24
Brown	10YR 5/3	1,2,3,12 to 15, 17,22,23,27 to 30	1,2,4,13,17,18, 19,21,23,28,29
Yellowish brown	10YR 5/6	Nil	22,25
Light brown	10YR 6/3	4,18,21,25,26	3,12,26,27,30

FIG. V . 1



MUNSELL SOIL COLOUR CHART

REPRODUCED FROM MUNSELL SOIL COLOUR CHARTS, 1954.

SOIL TEXTURE: The textural classes (Appendix V.1 p.247) for all augerbore soil samples were identified in the field by 'Feel Method' (Appendix V.2 p.248). Soil textures of a few augerbore soil samples were also studied in the laboratory to confirm the soil textural classes determined in the field. The details of variation in soil textural classes are given in Table V.3 on page 83 , under the laboratory investigations.

LIME CONTENT: The surface and the sub-surface soils were tested by dilute hydrochloric acid. The presence of free carbonates in the soil samples is indicated by nil, feeble, vigorous (strong) and violent effervescence.

The details of lime reaction, are given in the following table:

Lime Reaction	Augerbore Numbers	
	Surface Soil (0-15 cm)	Subsurface Soil (15-90 cm)
Nil	5,6,12,13,18,20, 21, 23 to 26,30	4,5,12,17,18,20 21,23 to 26, 30
Feeble	1,2,4,9,14,15,17, 19,22,27,28,29	7,10,13,15,19,22 28,29
Vigorous	3,4,8,10,16	1,8,14,16,27
Violent	11	2,3,6,9,11

SOIL MOISTURE: The surface soil is generally dry but at places it is just moist. The subsurface soil is generally just moist to moist.

The details of moisture variation in soils, are given in the following table:

Descriptive Name	Augerbore Numbers	
	Surface Soil (0-15 cm)	Sub-surface Soil (15-30 cm)
Dry	2,5 to 28,30	11,19,20
Just moist	1,3,4,29	1 to 5,7,9,12 to 18,22,23,24,26 to 30
Moist	Nil	6,8,10,21,25

PARENT MATERIAL: The nature of the parent material below the soil cover at each augerbore site, is given in the following table:

Parent Material	Augerbore Numbers
Deccan trap basalt	1,8,9,14,16
Wadhwan sandstone and shale	2,3,13,15
Dhrangadhra sandstone and shale	4 to 7,10,11,12, 17 to 30

The land features, viz. topography, erosion and depth to water table, are described below:

TOPOGRAPHY : It includes physiography, slope and drainage.

(a) Physiography: The physiography of the area is mostly mid lowland but at places it is represented by lowland and mid upland.

The details of variation in physiography of the area, are given in the following table:

Physiography	Augerbore Numbers
Lowland	15,18,24,25,26,30
Mid lowland	1,2,4,8,13,14,16,17,19 20,22,23,27,28,29
Mid land	3,5,6,7,9 to 12
Mid upland	21

(b) Slope : The slope ranges from nearly level to gently sloping near each augerbore site.

The details of variation in slope, are given in the following table:

Slope Range		Descriptive Name	Augerbore Numbers
%	Degree and minutes		
0 - 1	0' - 35'	Nearly level	1 to 4,6 to 25, 27 to 30
1 - 3	35' - 1°44'	Very gently sloping	5,26
Over 3	Over 1°44'	Gently sloping to strongly sloping	Nil

(c) Drainage : Drainage capacity of the area is generally well drained to moderately well drained.

The details of variation in drainage capacity, are given in the following table :

Drainage Capacity	Drainage Class	Augerbore Numbers
Poorly drained to imperfectly drained	D_1 - D_2	Nil
Moderately well drained	D_3	2,3,4,6 to 10,13,14, 16,17,19,24 to 30
Well drained	D_4	1,3,5,11,12,15,18, 20 to 23
Excessively drained	D_5	Nil

SOIL EROSION: The degree of soil erosion varies from slight to moderate.

The details of soil erosion status, are given in the following table:

Degree of soil Erosion	Erosion Symbol	Augerbore Numbers
Nil to slight	e_1	6,19
Moderate	e_2	1 to 5, 7 to 18, 20 to 30
Severe to very severe	$e_3 - e_4$	Nil

DEPTH TO WATER TABLE: The depth to water table in each open well near augerbore sites, varies from 3 to 15 meters.

The details of depth to water table, are given in the following table:

Depth to Water Table (meter)	Augerbore Numbers
Less than 3	Nil
3 - 6	5,6,8,20
6 - 9	1,2,4,7,11,13,15,16,19,24, 25,26,28,29
More than 9	3,9,10,12,14,17,18,21,22, 23,27,30

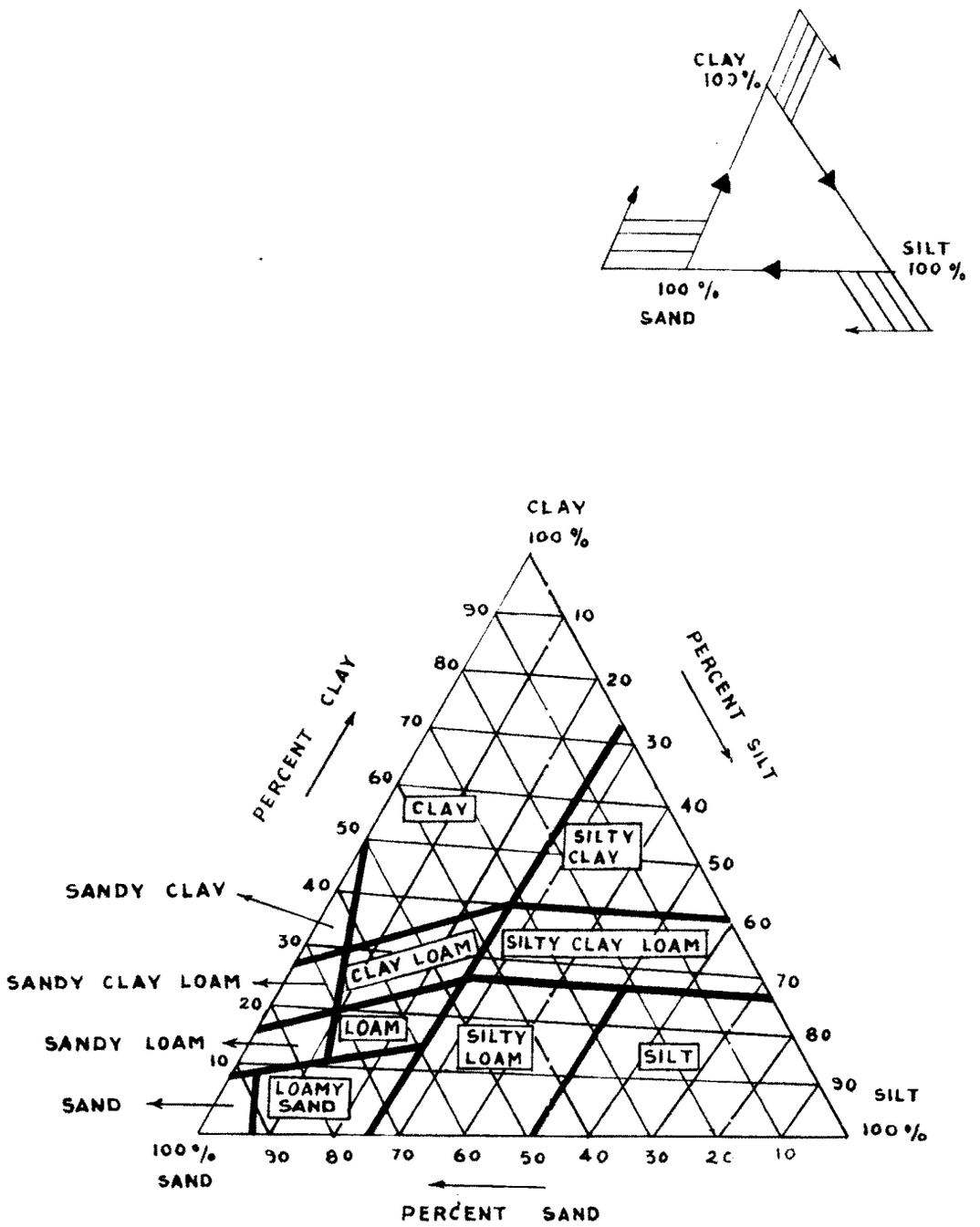
LABORATORY INVESTIGATIONS

The soil samples were tested for their physical and chemical properties as per IS:2720 (Methods of Test for Soils) in the laboratory. The test results of these properties are given in Table V.3. The physical and chemical characteristics, viz. soil texture, available water holding capacity, soil permeability, soil reaction and salinity, are described below:

SOIL TEXTURE (IS:2720 P.IV 1965): The details of the percentages of soil separates, viz. sand, silt and clay (Table V.3) of ten (Augerbore Nos. 1,2,6,9,10,13,14,18, 23,27) out of thirty augerbore soil samples, were determined by using pipette method. The textural classes were determined from the relative percentages of sand, silt and clay by using 'Triangular Textural Diagram' (Fig. V.2). The textural class of surface soil samples, varies from loamy sand to sandy loam and at places it is loam to clay loam. Clay as a soil textural class, is absent in this soil. The textural class of sub-surface soil samples, varies from sandy loam to clay loam and at places it is loamy sand or clay.

The details of depthwise variation in soil textural classes (Fig. V.3) determined in the field as well as in

FIG. V.2



TRIANGULAR TEXTURAL DIAGRAM

(REF :- SOIL SURYEY MANUAL , IARI , NEW DELHI , 1970, P-31)

the laboratory and the total area of each soil textural class, are given in the following table:

Soil Texture		Surface Soil		Sub-surface Soil	
Class Name	Symbol	Augerbore Number	Area (sq.km)	Augerbore Number	Area (sq.km)
Loamy Sand (Coarse textured)	ls	3,5,7,11,13 21,23	335.5	3,4,18 23,30	239.7
Sandy loam (Moderately coarse textured)	sl	4,12,15,18 19,22,24 to 28,30	575.2	2,6,12,15, 17,21,22,24, 25,26,29	527.2
Loam to Silty Loam (Medium textured)	1-Sil	1,2,6,10,14	239.6	1,13,14,19	191.7
Clay loam to Sandy clay loam (Moderately fine textured)	Cl to Scl	8,9,16,17 20,29	287.6	5,7,10,11, 16,20,27 28	383.4
Clay (Fine textured	c	nil	-	8,9	95.9
Total area			1437.9		1437.9

AVAILABLE WATER HOLDING CAPACITY : The constant* for available water holding capacity of each soil textural class is given in the following table:

*(1) Hand book on irrigation water management P-II-10, Published by water management division, Ministry of Agriculture, New Delhi.
(2) Guide used in making soil survey interpretations, USDASC, Forth Worth, Texas, 1965.

Textural class	Constant used for Available Water Holding Capacity
Coarse Sand	0.04
Fine sand	0.05
Loamy Sand	0.07
Loamy fine sand	0.08
Sandy loam	0.10
Fine sandy loam	0.13
Loam	0.14
Sandy clay loam	0.15
Clay loam, Silty clay loam & Sandy clay	0.17
Clay, Silty clay & Silty loam	0.16

The available water holding capacity for each textural class of each augerbore soil samples was calculated by multiplying the thickness (in centimeter) of that soil textural class with the relative constant given in the above table. The available water holding capacity (cm) upto a depth of 90 cm was calculated (Table V.4). The available water holding capacity for surface soil is 0 to 6 cm and that for sub-surface soil is 2 to 12 cm or more.

TABLE V.4

AVAILABLE WATER HOLDING CAPACITY (cm)
(Upto a depth of 90 cm)

Auger-bore No.	Location	Soil Textural Class	Available Water holding capacity		
			Thickness x Constant	Individual Total (cm)	Grand Total (cm)
1	2	3	4	5	6
1	Sayla	Loam	15 x 0.14	2.10	7.70
		Loam	40 x 0.14	5.60	
2	Bhaduka	Loam	15 x 0.14	2.10	6.85
		Sandy loam	30 x 0.10	3.00	
		Loamy sand	25 x 0.07	1.75	
3	Dolia	Loamy sand	15 x 0.07	1.05	3.15
		Loamy sand	30 x 0.07	2.10	
4	Chorvira	Sandy loam	15 x 0.10	1.50	2.55
		Loamy sand	15 x 0.07	1.05	
5	Than	Loamy sand	11 x 0.07	0.77	7.37
		Sandy clay loam	44 x 0.15	6.60	
6	Rampara	Loam	15 x 0.14	2.10	8.20
		Loamy sand	30 x 0.07	2.10	
		Sandy loam	40 x 0.10	4.00	
7	Shekhardi	Loamy sand	15 x 0.07	1.05	13.80
		Clay loam	33 x 0.17	5.61	
		Clay loam	42 x 0.17	7.14	

contd...

TABLE V.4 (contd.)

1	2	3	4	5	6
8	Jodhpur	Sandy clay loam	28 x 0.15	4.20	
		Clay loam	28 x 0.17	4.76	13.12
		Clay	26 x 0.16	4.16	
9	Sadharka	Sandy clay loam	20 x 0.15	3.00	
		Clay	40 x 0.16	6.40	14.20
		Clay	30 x 0.16	4.80	
10	Sarsana	Loam	15 x 0.14	2.10	
		Clay loam	30 x 0.17	5.10	14.85
		Clay loam	45 x 0.17	7.65	
11	Songadh	Loamy sand	10 x 0.07	0.70	9.70
		Sandy clay loam	60 x 0.15	9.00	
12	Vagadia	Sandy loam	15 x 0.10	1.50	6.00
		Sandy clay loam	45 x 0.10	4.50	
13	Khatdi	Loamy sand	15 x 0.07	1.05	7.05
		Loam	15 x 0.14	6.00	
14	N. of Sidsar	Silty loam	15 x 0.16	2.40	
		Silty loam	30 x 0.16	4.80	13.50
		Loam	45 x 0.14	6.30	

TABLE V.4 (contd.)

1	2	3	4	5	6
15	S of Sidsar	Sandy loam	15 x 0.10	1.50	
		Sandy loam	35 x 0.10	3.50	7.00
		Sandy loam	20 x 0.10	2.00	
16	N of Muli	Sandy clay loam	15 x 0.15	2.25	
		Sandy clay loam	30 x 0.15	4.50	12.75
		Sandy clay loam	40 x 0.15	6.00	
17	Dholia	Sandy clay loam	15 x 0.15	2.25	4.75
		Sandy loam	25 x 0.10	2.50	
18	Tarnetar	Sandy loam	15 x 0.10	1.50	
		Loamy sand	25 x 0.07	1.75	5.70
		Loamy sand	35 x 0.07	2.45	
19	Lunsar	Sandy loam	20 x 0.10	2.00	
		Sandy clay loam	30 x 0.15	4.50	11.40
		Loam	35 x 0.14	4.90	
20	Makhtanpur	Sandy clay loam	15 x 0.15	2.25	
		Sandy clay loam	25 x 0.15	3.75	9.00
		Sandy clay loam	20 x 0.15	3.00	

contd...

TABLE V.4 (contd.)

1	2	3	4	5	6
21	Ranipat	Loamy sand	15 x 0.07	1.05	
		Sandy loam	30 x 0.10	3.00	8.55
		Sandy loam	45 x 0.10	4.50	
22	Khampalia	Sandy loam	15 x 0.10	1.50	
		Sandy loam	30 x 0.10	3.00	5.90
		Loamy sand	20 x 0.07	1.40	
23	Sarla	Loamy sand	15 x 0.07	1.05	
		Loamy sand	30 x 0.07	2.10	6.30
		Loamy sand	45 x 0.07	3.15	
24	Tikar	Sandy loam	15 x 0.10	1.50	3.00
		Sandy loam	15 x 0.10	1.50	
25	Hirana	Sandy loam	15 x 0.10	1.50	
		Sandy loam	30 x 0.10	3.00	8.00
		Sandy loam	35 x 0.10	3.50	
26	Chitarkhada	Sandy loam	15 x 0.10	1.50	4.50
		Sandy loam	30 x 0.10	3.00	
27	Sagadhra	Sandy loam	15 x 0.10	1.50	
		Sandy loam	30 x 0.10	3.00	12.15
		Clay loam	45 x 0.17	7.65	
28	Rajgad	Sandy loam	15 x 0.10	1.50	6.00
		Sandy clay loam	30 x 0.15	4.50	

contd...

TABLE V.4 (contd.)

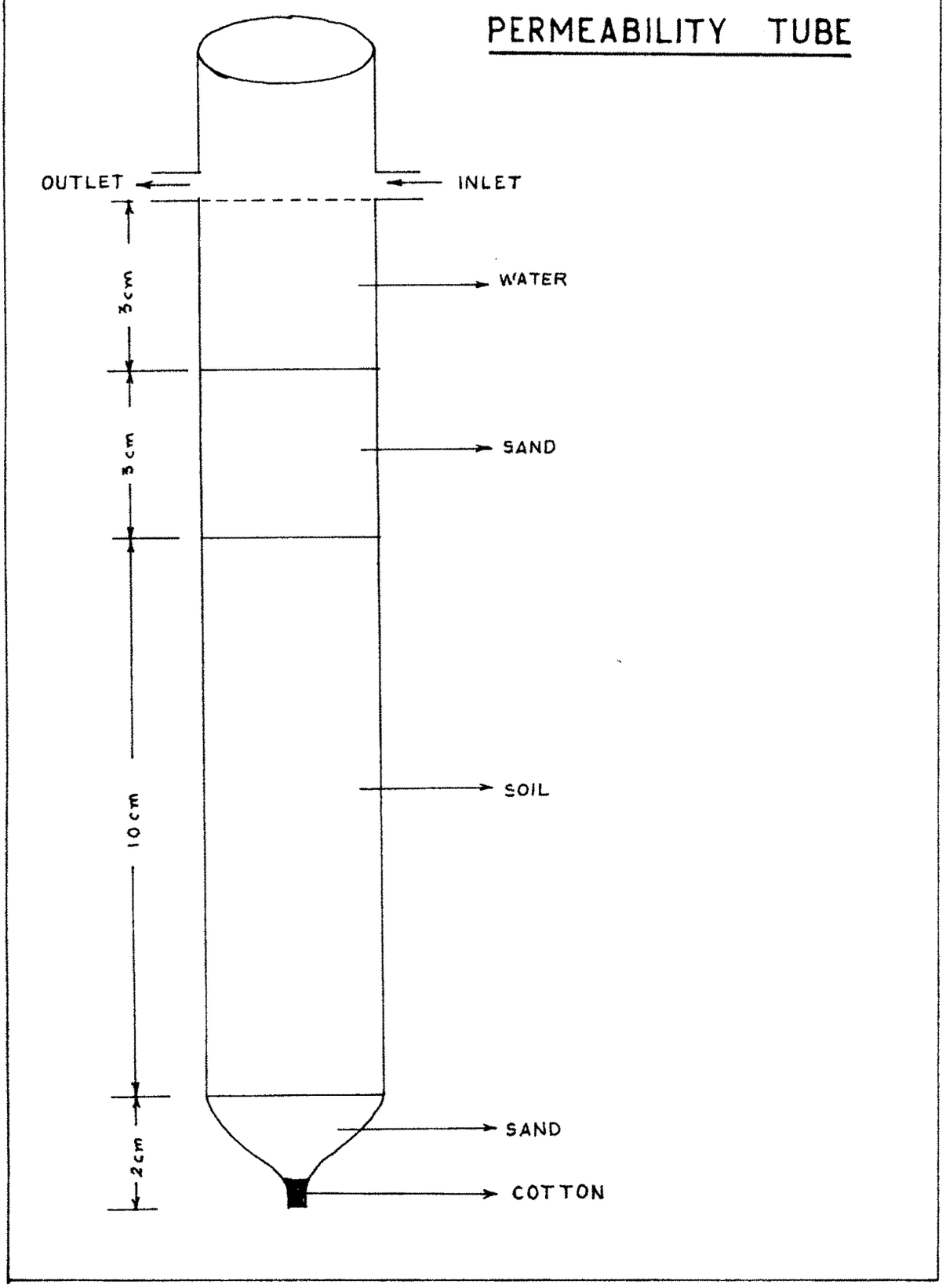
1	2	3	4	5	6
29	Aya Dagdagia	Sandy clay loam	15 x 0.15	2.25	5.25
		Sandy loam	30 x 0.10	3.00	
30	Palasan	Sandy loam	15 x 0.10	1.50	
		Sandy loam	30 x 0.10	3.00	6.75
		Loamy sand	35 x 0.07	2.25	

The variation in available water holding capacity for the depths of soil cover ranging from 0-15 cm, 15-90 cm and from 0-90 cm, are given in the following table:

Available Water Holding Capacity upto a Depth of 90 cm.	Augerbore Numbers		
	Surface Soil (0-15 cm)	Subsurface Soil (15-90 cm)	Total depth (0-90 cm)
Less than 2 cm	3,4,5,7,11, 12,13,15,18, 19,21,to 28, 30	4,24	Nil
2 - 6 cm	1,2,6,8,9, 10,14,16, 17,20,29	1,2,3,12,13, 15,17,18,22, 23,26,28,29, 30	3,4,12,17, 18,22,24, 26,28,29
6 - 9 cm	Nil	5,6,8,11,20, 21,25	1,2,5,6,13 15,20,21,23, 25,30
9 -12 cm	Nil	9,14,16,19,27	11,19
More than 12 cm	Nil	7,10	7 to 10,14, 16,27

SOIL PERMEABILITY (IS:2720 P.XVII,1966): Constant Head Permeameter (Fig. V.4) was used to measure the rate of water through saturated soil samples from each augerbores. The coefficient of permeability at room temperature, was determined in terms of cm/hr. Generally the degree of permeability for coarse grained soils, is rapid and that

FIG. V.4


PERMEABILITY TUBE
OUTLET
INLET
WATER
SAND
SOIL
SAND
COTTON
3cm
3cm
10cm
2cm

for fine grained soils, is slow. The coefficient of permeability for surface and sub-surface soils, ranges from 0.5 to 13.0 cm/hr.

The details of variation in the coefficient of permeability, are given in the following table:

Coefficient of Permeability (cm/hr)	Permeability Class Name	Augerbore Numbers	
		Surface Soil (0-15 cm)	Subsurface Soil (15-90 cm)
Less than 0.13	Very slow	Nil	8
0.13 - 0.50	Slow	Nil	9,10,14,24
0.50 - 5.00	Moderately Slow	1,2,4,5,6,8 to 17,19,20 to 25,27 to 30	1,3,to 7,11,12, 13,15,16,19,20 22,23,25 to 30
5.00 - 13.00	Moderately Rapid	3,7,18,26	2,17,18,21
More than 13.00	Rapid to Excessive	Nil	Nil

SOIL REACTION (IS:2720,PXXVI,1967): It is a measure of the acidity/alkalinity of a soil. pH meter was used to measure the pH values of the filtrate having 1:1 soil to water ratio. The pH values for the surface and the sub-surface soils, vary from mildly alkaline to moderately alkaline.

The details of variation in pH values, are given in the following table:

Soil Reaction		Augerbore Numbers	
Acidity/ Alkalinity	pH	Surface Soil (0-15 cm)	Subsurface Soil (15-90 cm)
Extremely acid to Slightly acid	Upto 6.5	Nil	Nil
Neutral	6.6 - 7.3	6	Nil
Mildly alkaline	7.4 - 7.8	1,2,12,13, 23 to 30	1,12,23,24,26, 29,30
Moderately alkaline	7.9 - 8.4	2,4,5,10,11, 14 to 22	2,3 to 7,10,11 13 to 20,22,25, 27,28
Strongly alkaline	8.5 - 9.0	7,8,9	8,9,21
Very Strongly alkaline	More than 9.1	Nil	Nil

SALINITY (IS:2720 P.XXI,1965): It is measured in terms of (a) electrical conductivity and (b) total dissolved salts of the filtrate obtained from 1:1 soil to water ratio.

(a) Electrical Conductivity: Conductivity meter was used to measure electrical conductivity value in EC x 10^{-3} (mmhos) of the filtrate.

The details in variation of electrical conductivity values of surface and sub-surface soils, are given in the following table:

EC Value (mmhos)	Concentration of Salts/Alkalies	Augerbore Numbers	
		Surface Soil (0-15 cm)	Subsurface Soil (15-90 cm)
Less than 4	Free	2 to 5,7 to 10,14 to 23, 25 to 28	1 to 23, 25 to 28,30
4 - 8	Slight to moderate	1,11,13,19,27	24,29
8 - 12	Moderately strong	6	Nil
More than 12	Very strong	24	Nil

(b) Total Dissolved Salts: The total dissolved salts measured in percentage were calculated from 10 ml filtrate.

The details in variation in the percentage of the total dissolved salts of surface and sub-surface soils, are given in the following table:

TDS (%)	Concentration of Salt/Alkalies	Augerbore Numbers	
		Surface Soil (0-15 cm)	Subsurface Soil (15-90 cm)
0. 0-0.25	Free	2 to 5,7 to 10,12,14 to 18,20 to 23, 25,26,28 to 30	2 to 5, 7 to 10, 12 to 19,21 to 23, 26 to 28,30
0.25-0.50	Slight to moderate	11,13,19,27	1,6,11,20,24,25,29
0.50-0.75	Moderately strong	1,6	Nil
Over 0.75	Very strong	24	Nil

Formulae used for calculations of various physical and chemical properties of augerbore soil samples during laboratory tests, are given in Appendix V.3 p.149.

LAND IRRIGABILITY CLASSIFICATION

It is based on the soil characteristics and the land features of an area. The criteria, for classifying the land into irrigability classes for semi-arid and arid regions, (IS:5510 - 1959) are given in Appendix V.4 p.151. In this classification, land irrigability is divided into six classes. Classes I to IV include land suitable for irrigation with some limitations. Class V relates to land considered temporarily as non-irrigable which may become irrigable with corrections and ammendments. Class VI is not at all suitable for irrigation purposes. It is included in non-irrigable land class.

SOIL IRRIGABILITY CLASSIFICATION

It is mainly based on the soil characteristics (Soil Survey Manual, 1970). In this classification, Soil irrigability is divided into five classes. Four classes - A to D belong to irrigable soil class and Class E belongs to non-irrigable soil Class (Appendix V.5 p.153).

SOIL/LAND IRRIGABILITY CLASSIFICATION OF THE STUDY AREA

The details of the parameters, viz. effective soil depth, soil texture, available water holding capacity, soil permeability, soil reaction, salinity, topography, drainage, depth to water table and soil erosion used for soil/land irrigability classification of the study area, are given (Table V.5). These parameters based on the results of the field observations and the laboratory investigations are described below:

(1) EFFECTIVE SOIL DEPTH: It refers to the soil thickness over hard rock or parent material below which root cannot pass.

The effective soil depth, at each augerbore site and the corresponding soil/land irrigability class, are given in the following table:

Effective Soil Depth (cm)	Augerbore Numbers	Irrigability Class	
		Soil	Land
Less than 22.5	Nil	E & D	VI,V & IV
22.5-45.0	3,4,13,17,24,26, 28,29	C	III
45.0-90.0	1,2,5,6,8,11,12 15,16,18 to 23, 27,30	B	II
More than 90.0	7,9,10,14,25	A	I

(2) SOIL TEXTURE: It is the fundamental and the most important property of the surface soil that is intimately related to soil water. It influences infiltration, water holding capacity, permeability, cohesion and plasticity. It is also influenced by the presence of clay minerals. Soil textural classes from 0-15 and 15-30 cm depth ranges and an average soil textural class upto a depth of 30 cm, are given in Table V.6. Surface soil textural map was prepared from the average soil textural class upto a depth of 30 cm at each augerbore site (Map V.2 Folder). Average textural class of surface soils upto a depth of 30 cm was considered for determining soil/land irrigability class at each augerbore site.

The textural class of top soils upto a depth of 30 cm, at each augerbore site and corresponding soil/land irrigability class, are given in the following table:

Textural Class	Augerbore Numbers	Irrigability Class	
		Soil	Land
Loamy Sand	3,23	B	II
Sandy loam	4,12,15,18,21,22,24 to 27, 30	A	I
Loam	1,2,6,13	A	I
Silty loam	14	A	I
Sandy clay loam	5,8,11,16,17,19,20,28,29	A	I
Clay loam	7,10	A	I
Clay	9	B,C,D	II to IV

TABLVE V.6

TEXTURAL CLASSES OF SOIL SAMPLES AT VARIOUS DEPTHS

Auger-bore No.	Village	Soil Textural Class (0 to 15 cm)	Soil Textural Class (15 to 30 cm)	Surface texture (0 to 30 cm)
1	2	3	4	5
1.	Sayla	Loam	Loam	Loam
2.	Bhaduka	Loam	Sandy loam	Loam
3.	Dolia	Loamy sand	Loamy sand	Loamy sand
4.	Chorvira	Sandy loam	Loamy sand	Sandy loam
5.	Than	Loamy sand	Sandy clay loam	Sandy clay loam
6.	Rampara	Loam	Loamy sand	Loam
7.	Shekhardi	Loamy sand	Clay loam	Clay loam
8.	Jodphur	Sandy clay loam	Clay loam	Sandy clay loam
9.	Sadharka	Sandy clay loam	Clay	Clay
10.	Sarsana	Clay loam	Clay loam	Clay loam
11.	Songadh	Loamy sand	Sandy clay loam	Sandy clay loam
12.	Vagadia	Sandy loam	Sandy loam	Sandy loam
13.	Khatdi	Loamy sand	Loam	Loam
14.	N of Sidsar	Silty loam	Silty loam	Silty loam
15.	S of Sidsar	Sandy loam	Sandy loam	Sandy loam

contd...

TABLE V.6 (contd.)

1	2	3	4	5
16.	N of Muli	Sandy clay loam	Sandy clay loam	Sandy clay loam
17.	Dholia	Sandy clay loam	Sandy loam	Sandy clay loam
18.	Tarnetar	Sandy loam	Loamy sand	Sandy loam
19.	Lunsar	Sandy loam	Sandy clay loam	Sandy clay loam
20.	Makhtanpur	Sandy clay loam	Sandy clay loam	Sandy clay loam
21.	Ranipat	Loamy sand	Sandy loam	Sandy loam
22.	Khampalia	Sandy loam	Sandy loam	Sandy loam
23.	Sarla	Loamy sand	Loamy sand	Loamy sand
24.	Tikar	Sandy loam	Sandy loam	Sandy loam
25.	Hirana	Sandy loam	Sandy loam	Sandy loam
26.	Chitarkhada	Sandy loam	Sandy loam	Sandy loam
27.	Sagadhara	Sandy loam	Sandy loam	Sandy loam
28.	Rajgad	Sandy loam	Sandy clay loam	Sandy clay loam
29.	Aya Dagdagia	Sandy clay loam	Sandy loam	Sandy clay loam
30.	Palasan	Sandy loam	Sandy loam	Sandy loam

(3) AVAILABLE WATER HOLDING CAPACITY: Available water holding capacity of soils upto a depth of 90 cm, at each augerbore site and the corresponding soil/land irrigability class, are given in the following table:

Available Water Holding Capacity (cm)	Augerbore Numbers	Irrigability Class Soil	Land
More than 12	7 to 10,14,16,27	A	I
9 - 12	11,19	B	II
6 - 9	1,2,5,6,13,15,20 21,23,25,30	C	III
2 - 6	3,4,12,17,18,22 24,26,28,29	D	IV
Less than 2	Nil	E	V to VI

(4) SOIL PERMEABILITY: Generally, the degree of permeability for fine grained soils containing montmorillonitic clay mineral, is slow and that, for very coarse grained soils containing Kaolinitic clay mineral, is very rapid.

The coefficient of permeability of a least permeable layer of soil upto a depth of 90 cm, at each augerbore site and the corresponding soil/land irrigability class, are given in the following table:

Coefficient of Permeability (cm/hr)	Augerbore Numbers	Irrigability Class	
		Soil	Land
Less than 0.13	Nil	C,D	III to IV
0.13 - 0.5	8 to 10,14,16,20,24	B	II
0.5 - 5.0	1 to 7,11, to 13,15, 17,21 to 23,25 to 30	A	I
5-0 - 13.0	8	B	II
13.0 - 25.0 and more	Nil	C,D	III to IV

(5) SOIL REACTION: It provides the maximum information about the soil condition. Low pH value (below 4) and very high pH value (above 8.5) are generally considered to be problematic for irrigation.

The details of maximum pH of soil, upto a depth of 90 cm, at each augerbore site and the corresponding soil/land irrigability class, are given in the following table:

Maximum pH	Augerbore Numbers	Irrigability Class	
		Soil	Land
6.6 - 7.3	Nil	A	I
7.4 - 7.8	1,12,23,24,26,29,30	B,C	II to III
7.9 - 8.5	2 to 11,13 to 22,25, 27, 28	B,C	II to III
More than 8.5	Nil	D,E	IV to V

(6) SALINITY: It indicates the presence of soluble salts which are generally bicarbonates, sulphates and chlorides of calcium, magnesium and sodium. It controls the availability of soil moisture and plant nutrients but it is harmful to the growing plants. It is measured in terms of electrical conductivity (mmhos) and total dissolved salts (percentage). The approximate correlation between electrical conductivity and percentage of total dissolved salts, is as follows:

EC		TDS
1	mmhos =	0.0625%
4	" =	0.25%
16	mmhos =	1.00%

(a) Electrical Conductivity: The details of maximum EC value of soil, upto a depth of 90 cm at each augerbore site and the corresponding soil/land irrigability class, are given in the following table:

EC (mmhos)	Augerbore Numbers	Irrigability Class	
		Soil	Land
Less than 4	2 to 5,7 to 10,12 to 19, 21 to 23, 25 to 28, 30	A	I
4 - 8	1,11,20,29	B	II
8 -12	6	C	III
More than 12	24	D,E	IV to VI

(b) Total Dissolved Salts: The details of maximum percentage of total dissolved salts in the soil, upto a depth of 90 cm, at each augerbore site and the corresponding soil/land irrigability class, are given in the following table:

TDS (%)	Augerbore Numbers	Irrigability Class	
		Soil	Land
0 - 0.25	2 to 5,7 to 10,12,14 to 18,21 to 23,26,28,30	A	I
0.25 - 0.50	11,13,19,20,25,27,29	B	II
0.50 - 0.75	1,6	C	III
Over 0.75	24	D	IV

(7) TOPOGRAPHY: It refers to the shape of land surface. Slope denotes an inclination of the land surface in relation to the horizontal plane and is expressed as a percentage.

The details of variation in slope near each augerbore site and the corresponding land irrigability class, are given in the following table:

Topography (Slope %)	Augerbore Numbers	Land Irrigability Class
0 - 1	1 to 4, 6 to 25 27 to 30	I
1 - 3	5, 26	II
Over 3	Nil	III to VI

(8) DRAINAGE: The external drainage which refers to the property of the soil that facilitates the removal of free water from soil by surface flow, is governed by land factors, viz. slope, vegetation, and surface conditions. The internal drainage which refers to the property of the soil that facilitates the passing of water through the soil, is controlled by soil permeability.

The details of variation in drainage capacity of the land near each augerbore site and the corresponding land irrigability class, are given in the following table:

Drainage Capacity	Augerbore Numbers	Land Irrigability Class
Poorly drained	Nil	III to Iv
Imperfectly drained	Nil	
Moderately well drained	2,3,4,6 to 10,13 14,16,17,19 24 to 30	I - II
Well drained	1,5,11,12,15,18, 20 to 23	I - II
Excessively drained	Nil	V & VI

(9) DEPTH TO WATER TABLE: The fluctuations in depth to water table have an important bearing in agriculture and irrigation uses.

The details of the variation in depth to water table near each augerbore site and the corresponding land irrigability class, are given in the following table:

Depth to Water Table (meter)	Augerbore Numbers	Land Irrigability Class
Less than 3	Nil	IV to VI
3 - 6	5,6,8,20	III
6 - 9	1,2,4,7,11,13,15,16 19,24,to 26,28,29	II
More than 9	3,9,10,12,14,17,18, 21 to 23, 27,30	I

(10) SOIL EROSION STATUS: It is associated with the loss of useful top soil, reduction in effective soil depth, loss of nutrients and declination in fertility of soil.

The details of variation in soil erosion status near each augerbore site and the corresponding land irrigability class, are given in the following table:

Soil Erosion Status	Augerbore Number	Land Irrigability Class
e_1 (Nil to slight)	6,19	I
e_2 (Moderate)	1 to 5, 7 to 18, 20 to 30	II
e_3 & e_4 (Severe to very severe)	Nil	II to VI

The soils of the study area are classified into irrigable soil/land class (I to IV classes) and non-irrigable soil/land class (V & VI classes). The results of field observations and laboratory investigations of each augerbore site for the purpose of soil/land irrigability classification, are given in Table V.7. The most limiting parameter is considered for deciding the soil/land irrigability Class. A soil/land having the most desirable parameters of a particular class is assigned to a lower

soil/land irrigability class due to the presence of even one undesirable parameter of a lower class (Table V.8). The extent and the boundaries of the irrigable soil/land classes (I to IV) and the non-irrigable soil/land classes (V to VI) based on the factors, viz. hills, gullies and rock exposures are shown (Map V.3 Folder).

The details of soil/land irrigability classes and their corresponding areas in sq km calculated by planimeter, are given in the following table:

Soil/land	Class	Area for Irrigable Soil/land class		Total Land Area	
		Sq.km	%	Sq.km	%
Irrigable	I	-		-	-
	II	331.0	28.9	331.0	23.0
	III	464.7	40.6	464.7	32.3
	IV	349.4	30.5	349.4	24.3
Total		1145.1	100.0		
Non-Irrigable	V & VI	246.7		246.7	17.2
Unclassified (Rlys, Roads, Rivers etc.)		46.2		46.2	3.2
Total		1438.0		1438.0	100.00

The irrigable soil/land classes cover 80% of the total area.

LAND CAPABILITY CLASSIFICATION

It is an interpretative grouping of soils mainly based on (1) the inherent soil characteristics (2) external land features and (3) environmental factors that limit the use of land. Different land use capability classes and nature of the limitations in their use are given in Appendix V.6 p.355.

The informations for the first two are mainly based on Soil survey work. Inherent Soil characteristics include colour, texture, structure, clay mineral type, permeability, parent material and soil reaction (pH). Each of the above factors have a definite role to play in behaviour of soil and its management. External land features include slope and erosion conditions along with minor features. Slope directly affects the rate of run-off and soil removal and indirectly affects the moisture absorbed by the soil. The degree of erosion indicates the degree of productivity and suggests future use and treatment to overcome climatic factor which can place limitations on land use. The other limitations are stoniness, alkalinity, salinity and high water table.

Factors influencing the land capability classification are given as follows:

In land capability classification, each factors, viz. soil, land features and climate may be considered separately and independent of each other.

SOIL: It includes soil depth, soil texture, soil permeability, and soil alkalinity. The soil depth ranges from moderately deep to deep. Hence the land capability of the area is indicated by Class-II and Class-III. The texture, permeability and alkalinity of soils indicate the land capability of the area as Class-I and Class-II.

LAND FEATURES: They include slope, drainage, erosion and depth to water table. The slope ranges from nearly level to very gently sloping (excluding the hilly areas). Hence the land capability of the area is indicated by Class-II and Class-III. The drainage, erosion and depth to water table indicate the land capability of the area as Class-I and Class-II.

CLIMATE: The semi-arid climate of the area indicates the land capability as Class-III and Class-IV.

The most limiting factor is considered for deciding the land capability class. In general, the land capability of the study area is indicated by Class-III and Class-IV.